Example 1

This prime contractor established a Certified Supplier Program based on the commodities being purchased. Within these commodity programs there are two that are based on Statistical Process Control; printed wiring boards and semiconductors.

In the printed wiring board program the suppliers must agree to implement SPC and provide monthly data, in a format which is agreed upon by the procuring activities' Procurement Quality Engineer and the supplier's Quality Manager. The processes under control, as a minimum, must include:

- Copper Plating Thickness
- Etching (line/pad definition)
  Plated Through Hole Etch-back (per MIL-P-55100 specified limits)
- Drilling Accuracy (hole size and location)
- Final Inspection ("Group A" requirements)
- Solderability (per CACD specification)
- Tin/Lead Plating (thickness)

The Procurement Quality Engineer surveys the prospective supplier to assure that the SPC data is being properly recorded and analyzed. Once a satisfactory survey is completed, the supplier must run for thirty days without exceeding the control limits on all processes; once this has occurred the supplier is certified.

It should be noted that, if any time during the recording period the process limits are

exceeded, the supplier must provide written corrective action.

In the Semiconductor area, several major programs require parts be rescreened if not purchased from a supplier who maintains his processes to 100 parts per million.

Suppliers are certified using a process that provides prospective suppliers with a questionnaire that is completed by the supplier and returned to the procuring activity. Based on the returned questionnaire, the procuring activity schedules visits to the suppliers and verified that they have adequate SPC procedures in place and they are adequately performing to them. If everything is satisfactory, the Procurement Quality Engineer certified the suppliers product line or specific part number.

The major difference in the two programs is that the semiconductor suppliers are certified by product line or a part number while the printed wiring board suppliers have a facility certification.

These certified supplier programs eliminate the non value added task of rescreening and reduce the amount of direct labor that goes into performing receiving inspection. In the first six months of a typical year, the savings exceeded $500,000.

Example 2

This government agency has three strategies for motivating SPC/CPI.

a. SPC being a contractual requirement for major item production procurements.

b. SPC being a key component of the Contractor Performance Certification Program.

c. Allowing reduction of Technical Data Package (TDP)/Specification inspection requirements for contractors meeting certain specific SPC criteria.

In general, scrap, reject and rework costs have decreased for those contractors using SPC. However, it is very difficult and time consuming to identify the exact savings due to SPC.

Example 3

Some prime contractors emphasize a team approach, focused on their strategic suppliers. The prime contractor forms a cross-functional team (typically including specialists in manufacturing, engineering, procurement, and quality). The teams meet

with the supplier, who forms a similar team. The prime contractor team is trained in SPC/CPI techniques and works to provide or obtain similar training for the supplier. The teams work together to clarify requirements, and identify key supplier processes to be controlled using SPC techniques. Based on an in-depth analysis of these key processes, specific pulse points are selected as being leading indicators of the stability and capability of the processes. Agreement is reached on what data and format is most appropriate to monitor the specific process points chosen. This SPC/CPI data is forwarded to the prime contractor team for review. This allows the prime contractor to have increased confidence in the suppliers' material and to provide additional help to the supplier if the data indicates a developing problem.

Example 4

For this government agency, SPC is called out by contract clause and an associated Data Item Description (DID). The clause/DID is very specific and requires that the contractor review process/operation parameters for possible application of SPC techniques. It further states that the review include processes/operations under the control of the prime contractor and those under the control of the subcontractor or vendor.

While successful, effective implementation of SPC at some contractor/sub-contractor facilities has been limited. Many reasons have been given but most center on lack of commitment by contractor top management and a lack of enforcement of the SPC contractual requirements. Also, SPC training for both Government and contractor personnel was initially approached in a shot-gun
manner.

Example 5

This procuring activity incentivized its contractor to expand the use of SPC/CPI by including in the contract three reports on TQM activity with a total award fee value of about $75K (total contract exceeded $100M). These reports detailed how the contractor implemented innovative TQM techniques and were scored on a sliding scale such that only exceptional performance received the full award fee. Furthermore, the money could only be spent on the employees. The first report has been submitted and received the highest possible score. The employees decided to use the award to take everybody on the program, and their families, to a major amusement park on a Saturday.

The parties concerned classify it as a win/win/win situation. The procuring activity has a report containing descriptions of excellent techniques that can be used with other

suppliers. The contractor has a motivated work force. The employees have pride in their documented accomplishments and the recognition from their management and their customers.

Example 6

In this company, associates who work on the factory floor were initially given several classroom hours of basic SPC training. Continuing fundamental on-the-job training was offered at frequent intervals by a quality specialist and/or local supervisor. This application process was reinforced by voluntary attendance at a weekly one-hour morning meeting, during which time success stories and 45-minute tutorials on techniques (with time for questions from the audience) were featured. Strong support for SPC activities was evidenced by both top and middle management.

Top management initiated a company wide continuous-improvement initiative, while middle management showed personal support by "walking the talk" and constantly fostering the methods. A key success factor was the emphasis on enlarging customer satisfaction and striving for continuous process improvement, rather than on the creation of SPC and Pareto charts. Notable advances were made in eliminating the special causes for discrepancies, although there was less success in eradicating common-cause problems.

The value of an SPC chart or a Pareto chart as tangible evidence that management expected improved performance was greater than their value as analytical tools. People who otherwise showed initiative and imagination in creating solutions admitted that they did not understand all the features of a control chart. Its true value was that of a positive attitude-builder. Defect reduction in some cases was just short of dramatic-levels of approximately 40 ppm were reached in some manufacturing operations. This was on the order of one to two magnitudes less than were being experienced several years before.

Example 7

This company, engaged in providing complex and expensive products at very low rates (2-5 per month), organized its entire manufacturing workforce into natural work groups and trained each work group as a team. SPC was established company-wide in 3 months on all product lines, although there were no contract requirements for SPC. Top management led the initiative, with the intent to regain lost schedules and improve profitability. Design, Quality and Manufacturing Engineers identified the key parameters for SPC control and gave "just in time" training to the production operators. Most key parameters were not the "critical or major" parameters

associated with the drawings. Within 9 months, most programs were back on schedule, "end to end" yields were up by factors of 2 to 3 and losses had stopped. The management support was made visible with Vice Presidents conducting daily 45 minute walks through production areas on a scheduled basis. This success was significantly expanded when Design, Manufacturing and Procurement Engineers were added to the "natural work groups" and these groups were given team training in the tools of defect prevention. Each team is authorized an hour per week to meet in a conference room setting to study their processes and devise ways to improve them. In nine months, yields increased as much as 6-fold while cycle times dropped as such as 10-fold. Over 90% of programs are ahead of schedule while the company moved from major losses to excellent profits. In two production areas, inspection points have been deleted in favor of production operator self-assessments.

Example 8

The Division Statistician in cooperation with a Quality Engineer in the Machine shop purchased a Datamyte SPC system and digital gauging to automate a SPC system at a Machine Center making precision missile servo components. The Quality Department (QE and inspector) worked with the machine attendant to implement the system. Manufacturing supervision and management saw this as an added task which, at times, interfered with throughput. At times the system performed well, depending on the knowledge and persuasion skills of the QE. The successes, although published in the Division paper, did not result in expanding the use of SPC beyond this area. This effort failed to provide a "launch platform" for Division wide SPC. It was seen as a Quality Department initiative and Manufacturing gave SPC little, if any, support.

Example 9

The Division had a major Fixed Price program about two years behind schedule and 40% over budget. All weapon system components and subsystems had been completed, but Final Assembly and Test personnel were unable to "harmonize" the several sub- systems successfully.

Top Management agreed to a new approach for "Process Control" because the Operators (hourly production workers) had no "machine or process adjustments" under their direct control. The new approach featured the establishment of a cross functional Engineering team (System, Design, Manufacturing and Quality Engineers), which performed the following activities:

(1) Estimate achievable process yield for each operation step.

(2) Maintain a weekly tabulation of process yield for each operation step.

(3) Compute overall end-to-end yield of the entire system integration, test, and acceptance process - made up of 9 of the sequential operation steps identified in (1) above; plot the results over time.

(4) Each week create Shewhart charts, histograms and compute CP/CPK for each of about 100 test parameter measurements stored on floppy disks.

(5) Create Pareto charts for test failures and test failure operation step location.

This cross-functional team used this data to identify and agree on the five most serious production inhibitors. Manufacturing Process and Design adjustments and changers were made to bring the process under control and, in many cases, reduce process variability. This program experienced a complete turn around in that schedules were held (for the first time) and the financial "bleeding" stopped.

Example 10

In the early 1980's this contractor, like many defense contractors, experienced a period of prosperity in the form of numerous contracts. The motivation to pursue Continuous Improvement activities was thus overshadowed.

In 1984, this contractor initiated employer involvement in the form of "Quality Circles." Teamwork facilitators were trained and team members were trained to use team work. While this effort was a move in the right direction, it missed the continuous improvement target.

At the end of 1985 SPC was initiated. Employee training was implemented in 1986 and continued through 1990. Approximately 560 salaried and hourly employees received a minimum of 10 hours of classroom training. We now had an excellent tool to measure variation in our processes. But again, we missed our continuous improvement target because we found our trainees were having difficulty taking lessons learned in the classroom and applying them in their work environment.

Each of these efforts produced positive results but fell short of expectations because of insufficient experience, vision or leadership. We concluded: even when you know what to do, a lack of constancy of purpose and failure to follow up will usually produce limited results. We discovered that few are completely successful in

implementing TQM/CPI and SPC if the vision is too narrow and success is expected in a short time. Those that succeed are willing to take the bumps and bruises that go with a long term implementation. Those who aren't willing to accept this, fail.

In 1989 new leadership infused a long term top management commitment to SPC and CPI (TQM) as an organizational goal. Along with this, a new organization was formed that was staffed with full-time facilitators and trained experts in SPC, QFD, TQM, JIT/Waste Elimination, problem solving tools and other process improvement skills. We changed our training methods (SPC in particular) to provide training that fits a particular process and process owner. We began to understand the culture that we needed to change and the time needed to change it.

We formed our own recipe which provided the essential ingredients for change.

1. A visionary champion who understands the differences between processes and functions.

2. A full-time implementation organization.

3. A training program that provides for the immediate needs of the process owner.

4. An implementation model and a plan that identifies and measures processes.

Along with this, we committed to organizing and managing the business consistent with TQM principles. We pushed the decision authority to the lowest level and focused on our customers - both internal and external. Measures in every aspect of our business were established to monitor progress.

Of all the obstacles faced when implementing SPC or CPI we found changing the culture was the most difficult and time-consuming. Training must focus on understanding variation in processes and the need to reduce that variation. The process owner must accept ownership of his process and intuitively react to results of his data collection.

Example 11

We have a subcontractor who provides an assorted variety of sheet metal fabricated components to us. Our real relationship with them began when the subcontractor's CEO attended one of our Supplier Symposiums where we introduced our vision for

TQM. During our discussions, he revealed his determination to improve quality using SPC. We were delighted to find one of our suppliers pursuing process improvement eagerly on their own and thus began what we hoped would be a lasting relationship.

We invited this CEO to attend our 4 day in-house training for implementing continuous improvement. These training modules were performed off site and tailored to our needs and our business.

Due to our interest in forming quality partnerships, we invited this subcontractor to become a pilot project partner and the CEO accepted. We assigned a facilitator to visit the subcontractor one day each week to assist them in forming teams and to provide training in the use of problem identification and problem solving tools.

The subcontractor's CEO formed a team of workers and engineers and chartered them to improve the process of a complex sheet metal periscope cover which had an acceptance rate history of only 61%. The team began to meet, and with the support of their customer's full time facilitator, they began to utilize the appropriate problem solving tools. Part of each meeting was dedicated to training and then applying their actual data to the lessons learned. The team flow charted the process and input from the process owners resulted in revised fixturing with locator timing blocks, instituting quick on-line Go-No-Go inspection points and real time inspection and data collection by the process owners. Being able to utilize their SPC data and team work helped to resolve the inconsistencies with this component and achieve a 100% acceptance rate on the more than 100 deliveries of this component since.

The customer and subcontractor are now computer linked so that the customer can constantly monitor real time data collected by the process owners on this and other components that are being evaluated with SPC.

Example 12

A Government Agency is responsible to maintain an up to date approved supplier list. Suppliers were approved based on a formal screening completed on a random sample of the suppliers every month.

This Agency developed a metric to determine whether or not the approval process was performed correctly. The data was plotted on an "np" attributes chart. Over a period of time, the np chart data indicated that the process was in control, thus no special cause of variation was present. Nevertheless, the average (np) associated with this "in control" process indicated an unacceptably high number of defective (incorrect) approvals.

It was recognized that to reduce the number of incorrect approvals (defects), process changes were needed to reduce common causes of variation. The following changes were made:

- new supplier survey procedures were developed
- training was provided to the personnel conducting the surveys

The result was a decrease of the average error rate (np) from 14% to 3%, a rate deemed acceptable.